Ecosystem properties of semi-arid savanna grassland in West Africa and its relationship to environmental variability

The Dahra field site in Senegal, West Africa, was established in 2002 to monitor ecosystem properties of semi-arid savanna grassland and their responses to climatic and environmental change. This article describes the environment and the ecosystem properties of the site using a unique set of in situ data. The studied variables include hydroclimatic variables, species composition, albedo, normalized difference vegetation index (NDVI), hyperspectral characteristics (350-1800 nm), surface reflectance anisotropy, brightness temperature, fraction of absorbed photosynthetic active radiation (FAPAR), biomass, vegetation water content, and land-atmosphere exchanges of carbon (NEE) and energy. The Dahra field site experiences a typical Sahelian climate and is covered by coexisting trees (~3% canopy cover) and grass species, characterizing large parts of the Sahel. This makes the site suitable for investigating relationships between ecosystem properties and hydroclimatic variables for semi-arid savanna ecosystems of the region. There were strong interannual, seasonal and diurnal dynamics in NEE, with high values of ~7.5 g C m⁻² day⁻¹ during the peak of the growing season. We found neither browning nor greening NDVI trends from 2002 to 2012. Interannual variation in species composition was strongly related to rainfall distribution. NDVI and FAPAR were strongly related to species composition, especially for years dominated by the species Zornia glochidiata. This influence was not observed in interannual variation in biomass and vegetation productivity, thus challenging dryland productivity models based on remote sensing. Surface reflectance anisotropy (350-1800 nm) at the peak of the growing season varied strongly depending on wavelength and viewing angle thereby having implications for the design of remotely sensed spectral vegetation indices covering different wavelength regions. The presented time series of in situ data have great potential for dryland dynamics studies, global climate change related research and evaluation and parameterization of remote sensing products and dynamic vegetation models.

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